Giancoli Ch 39-14: Fee electron wave function.

Define useful constants.

$amu \equiv 1.66054 \cdot 10^{-27} \cdot kg$ $nm \equiv 10^{-9} \cdot m$ $h_{bar} \equiv 1.054573 \cdot 10^{-34} \cdot joule \cdot sec$

$k_B \equiv 1.380658 \cdot 10^{-23} \cdot \frac{joule}{K}$ $c \equiv 2.99792458 \cdot 10^{8} \cdot \frac{m}{sec}$ $h \equiv 2 \cdot \pi \cdot h_{bar}$

$m_e \equiv 9.11 \cdot 10^{-31} \cdot kg$ $q \equiv 1.602177 \cdot 10^{-19} \cdot coul$

$N_A \equiv 6.022137 \cdot 10^{23} \cdot \frac{1}{mole}$

$\varepsilon_0 \equiv 8.854188 \cdot 10^{-12} \cdot \frac{farad}{m}$ $kJ \equiv 10^{3} \cdot joule$

$eV \equiv q \cdot volt$ $\mu m \equiv 10^{-6} \cdot m$

$m_n \equiv 1.008665 \cdot amu$

A free electron has a wave function given by ψ(x)=Asin(1.0x10^{10}x) with x in meters. Find wavelength, momentum, speed, energy.

The general form for the wavefunction of a free particle is given by ψ(x)=Asin(kx) where k is the wave vector. From inspection we conclude:

$k := 1 \cdot 10^{10} \cdot m^{-1}$ Note that with x in meters, k is in inverse meters.

See the various equations in the chapter to verify the following assignments.

$\lambda := \frac{2 \cdot \pi}{k}$

$\lambda = 0.628 \cdot nm$

$p := h_{bar} \cdot k$

$p = 1.055 \cdot 10^{-24} \cdot kg \cdot m \cdot sec^{-1}$

$v := \frac{p}{m_e}$

$v = 1.158 \cdot 10^{6} \cdot m \cdot sec^{-1}$

$KE := \frac{p^2}{2 \cdot m_e}$

$KE = 6.104 \cdot 10^{-19} \cdot joule$

$KE = 3.81 \cdot eV$